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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/885,232	06/20/2001	Linlin Chen	291958163US2	4989

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EXAMINER
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NICOLAS, WESLEY A

ART UNIT	PAPER NUMBER
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1742

DATE MAILED: 11/05/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

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<b>Office Action Summary</b>	Application No. 09/885,232	Applicant(s) CHEN, LINLIN	
	Examiner Wesley A. Nicolas	Art Unit 1742	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is FINAL.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 60-86 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 60-86 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.  
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

**Priority under 35 U.S.C. §§ 119 and 120**

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).  
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                                | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s). ____   |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                       | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449) Paper No(s) <u>5</u> | 6) <input type="checkbox"/> Other:  |

## **DETAILED ACTION**

### ***Specification***

1. The disclosure is objected to because of the following informalities: The title should be changed so that it corresponds with the claims. A suggested title is, "Method for electrolytically depositing copper on a semiconductor workpiece."

Appropriate correction is required.

### ***Claim Objections***

2. Claim 85 is objected to because of the following informalities: "5.o" should be changed to --5.0--.

Appropriate correction is required.

### ***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

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5. Claims 60-61, 68, 73, and 79-80 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sonnenberg et al. (5,252,196), and further in view of Herr (4,134,802).

Sonnenberg et al. teach a process for applying a metal structure to a workpiece comprising:

- providing a first electroplating bath including a source of metal ions as a principal metal species (Examples 1-5: "CuSO<sub>4</sub>") to be deposited during subsequent electroplating, and a metal ion complexing agent (col. 11: "complexing surfactants");
- providing a workpiece on which one or more microelectronic devices are to be formed (col. 12: "printed circuit board");
- exposing at least one surface of the workpiece to the first electroplating bath (Examples 1-5);
- applying electroplating power between the at least one surface of the workpiece and an electrode disposed in electrical contact with the first electroplating bath to electroplate the principal metal species onto the at least one surface of the workpiece in an electrolytic first deposition process (Examples 1-5), wherein power is applied during at least a portion of the first deposition process for a workpiece surface current density of between 1.0 mA/cm<sup>2</sup> and 5.0 mA/cm<sup>2</sup> (col. 12: "current ranging between 1 and 40 ASF" where 1 ASF = .929 mA/cm<sup>2</sup>).

Sonnenberg et al. fail to specifically teach the use of boric acid, but does teach the use of a buffer (col. 9, "buffer").

Herr teaches that boric acid is commonly used as a buffer (col. 5, lines 65-68).

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Claim 60 is rejected because it would have been obvious and within the ordinary skill in the art at the time the invention was made to have modified Sonnenberg et al. to use a buffer such as boric acid as taught by Herr because Herr teaches that boric acid is commonly used as a buffer because of its ability to stabilize the pH of the solution (col. 5, lines 65-68).

Claim 61 is rejected because Sonnenberg et al. teach a current density of about  $2.0 \text{ mA/cm}^2$  (col. 12: "current ranging between 1 and 40 ASF" where  $1 \text{ ASF} = .929 \text{ mA/cm}^2$ ).

Claim 68 is rejected because Sonnenberg et al. teach that the metal deposited is copper (col. 1: "copper is electroplated").

Claim 73 is rejected because Sonnenberg et al. teach that the bath includes a conformality increasing agent (*i.e.* leveling agent) (cols. 10 and 11).

Claims 79 and 80 are rejected because Sonnenberg et al. teach a complexing agent which is a polycarboxylic acid such as citric acid (col. 11: *i.e.* "citric acid").

6. Claim 62 is rejected under 35 U.S.C. 103(a) as being unpatentable over the Sonnenberg et al. - Herr combination, as applied to claim 60 above, and further in view of Nobel et al. (Re 35,513).

The Sonnenberg et al. - Herr combination are as applied, argued, and disclosed above and incorporated herein but fail to specifically teach the power application time period of between 1.0 and 5.0 minutes.

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Nobel et al. teach that one can apply power to a workpiece for 1.5 and 5.0 minutes (Examples 3 and 4).

Claim 62 is rejected because it would have been obvious and within the ordinary skill in the art at the time the invention was made to have modified the Sonnenberg et al. - Herr combination to use a power application of 1.5 or 5.0 minutes as taught by Nobel et al. because Nobel et al. teach that such a power application results in smooth, bright coatings (Examples 3 and 4).

7. Claims 63-64, 78, and 83-84 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Sonnenberg et al. - Herr combination, as applied to claim 60 above, and further in view of Dubin et al. (5,972,192).

The Sonnenberg et al. - Herr combination are as applied, argued, and disclosed above and incorporated herein but fail to specifically teach:

- that the power is applied in periodic pulses,
- that the power is applied in forward pulses having a period of about 2 msec at a 50% duty cycle,
- depositing an ultra-thin seed layer of metal onto the barrier layer before the first deposition process,

Regarding claims 63 and 83, Dubin et al. teach that the power is applied in periodic pulses (cols. 5-8).

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Regarding claims 64 and 84, Dubin et al. teach that the power is applied in forward pulses having a period of about 2 msec at a 50% duty cycle (Example 2).

Regarding claim 78, Dubin et al. teach of depositing an ultra-thin seed layer of metal onto the barrier layer before the first deposition process (col. 7: "seed layer and/or barrier layer").

Claims 63-64, 78, and 83-85 are rejected because it would have been obvious and within the ordinary skill in the art at the time the invention was made to have modified the Sonnenberg et al. - Herr combination using the process conditions as taught by Dubin et al. because Dubin et al. teach that said process conditions (periodic pulses, pulse time, duty cycle, and seed layer) provide for even plating of trenches resulting in bottom up filling (cols 5-8, Example 2, col. 7: "seed layer and/or barrier layer", and Abstract).

8. Claim 85 is rejected under 35 U.S.C. 103(a) as being unpatentable over the Sonnenberg et al. - Herr - Dubin et al. combination, as applied to claim 84 above, and further in view of Nobel et al. (Re 35,513).

The Sonnenberg et al. - Herr - Dubin et al. combination are as applied, argued, and disclosed above and incorporated herein but fail to specifically teach the power application time period of between 1.0 and 5.0 minutes.

Nobel et al. teach that one can apply power to a workpiece for 1.5 and 5.0 minutes (Examples 3 and 4).

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Claim 85 is rejected because it would have been obvious and within the ordinary skill in the art at the time the invention was made to have modified the Sonnenberg et al. - Herr - Dubin et al. combination to use a power application of 1.5 or 5.0 minutes as taught by Nobel et al. because Nobel et al. teach that such a power application results in smooth, bright coatings (Examples 3 and 4).

9. Claims 70-72, 74, 82, and 86 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Sonnenberg et al. - Herr combination, as applied to claim 60 above, and further in view of Couble et al. (U.S. 6,565,731).

The Sonnenberg et al. - Herr combination are as applied, argued, and disclosed above and incorporated herein but fail to specifically teach:

- an alkaline electroplating bath, with a pH of at least 9;
- wherein said bath is adjusted with an agent such as ammonium hydroxide;

Regarding claims 70-71, 82, and 86, Couble et al. teach of an alkaline agent sufficient to adjust the pH of the electroplating bath to at least 9.0 (col. 10, lines 20-32).

Regarding claim 72, Couble et al. teach that the pH is adjusted with an alkaline agent such as ammonium hydroxide (col. 12, lines 1-6).

Regarding claim 74, Couble et al. teach of a conformality increasing agent such as ethylene glycol (col. 10, lines 10-20).

Claims 70-72, 74, 82, and 86 are rejected because it would have been obvious and within the ordinary skill in the art at the time the invention was made to have



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modified the Sonnenberg et al. - Herr combination to use an alkaline agent such as ammonium hydroxide to adjust the pH to at least 9.0 and a conformality increasing agent such as ethylene glycol as taught by Couble et al. because Couble et al. teach that use of an alkaline agent to keep the pH above 9.0 provides adequate dispersion of particles and a conformality increasing agent which ensures constant reproducible results (col. 10, lines 10-32 and col. 12, lines 1-6).

10. Claims 75-77 are rejected under 35 U.S.C. 103(a) as being unpatentable over the Sonnenberg et al. - Herr - Couble et al. combination, as applied to claim 74 above, and further in view of Dubin et al. (5,972,192).

The Sonnenberg et al. - Herr - Couble et al. combination are as applied, argued, and disclosed above and incorporated herein but fail to specifically teach:

- depositing an ultra-thin seed layer of metal onto the barrier layer before the first deposition process,

Regarding claims 75-77, Dubin et al. teach of depositing an ultra-thin seed layer of metal onto the barrier layer before the first deposition process (col. 7: "seed layer and/or barrier layer").

Claims 75-77 are rejected because it would have been obvious and within the ordinary skill in the art at the time the invention was made to have modified the Sonnenberg et al. - Herr - Couble et al. combination using the process conditions as taught by Dubin et al. because Dubin et al. teach that said deposition of a seed layer

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would have provided for even plating of trenches resulting in bottom up filling (col. 7: "seed layer and/or barrier layer", and Abstract).

***Allowable Subject Matter***

11. Claims 65 and 81 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

12. The following is a statement of reasons for the indication of allowable subject matter:

The specific process conditions as set forth in claims 65 and 81 were not taught or suggested by the prior art of record.

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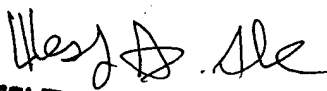
**Conclusion**

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley Nicolas whose telephone number is (703)305-0082. The examiner can normally be reached on Mon.-Thurs. from 7am to 5pm.

The Supervisory Primary Examiner for this Art Unit is Roy King whose telephone number is (703) 308-1146.

The fax number for this Group is (703) 872-9310.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0661.

  
**WESLEY A. NICOLAS**  
**PATENT EXAMINER**

November 3, 2003